DRAFT
PRELIMINARY EVALUATION OF THE IMPLICATIONS OF
AIRBORNE ASBESTOS EXPOSURE CONCENTRATIONS OBSERVED
DURING SIMULATION OF A SELECTED SET OF COMMON, OUTDOOR
RESIDENTIAL ACTIVITIES CONDUCTED AT
THE NORTH RIDGE ESTATES SITE, KLAMATH FALLS, OREGON

Introduction

The U.S. Environmental Protection Agency (EPA) conducted a special study at the North Ridge Estates Site in Klamath Falls, Oregon on July 20-22, 2004. During this study, contractors (in full protective gear) conducted simulations of a selected set of dust generating activities performed by residents at the site. The objective was to obtain measurements of airborne concentrations of asbestos that would bound exposures experienced by residents while conducting the activities selected.

Although not a design objective for this study, it is also instructive to compare risk estimates extrapolated from the exposure concentrations estimated in the simulation study with the modeled risk estimates presented in the recent, preliminary soil report for the site (Berman 2004). However, such comparisons must be made with care because the two studies do not provide the same kinds of estimates. Further, because the EPA study was not designed with this purpose in mind, measurements of various supplemental parameters required for full evaluation of the models were not developed.

While the estimates from the current simulations and the earlier soil report are both intended to provide conservative estimates of risk, the simulation provides a conservative estimate that is only a single, "snap-shot" in time. In contrast, the exposure and risk estimates from the soil report represent conservative estimates of long-term average exposures contributed by the various activities. Thus, even if the estimates from the simulation are adjusted for duration and frequency of exposure, this still ignores the effects of the time-variation of other inputs to the risk estimates. For example, such adjustments would still incorporate an assumption that the driest conditions persist throughout the year. Moreover, when evaluating the simulations, it is important to account for the uncertainty in the measurements, a factor that is not applicable to the models (which, in turn, address other sources of uncertainty). Thus, the manner in which conservatism is built into each estimate and the degree to which each estimate is conservative are not directly comparable.

Study Design

Although the details of the design of the study have been provided elsewhere (E and E 2004), a summary is presented here to provide the framework within which study results can be interpreted.

Three activities were selected for simulation:
1. a child-playing in dirt, during which a gallon bucket was repeatedly filled and emptied;
2. weed trimming using a nylon cord weed trimmer; and
3. rototilling.

Multiple trials (up to four) were conducted for each activity in an attempt to determine both a conservative mean for the simulations (under the specific conditions evaluated) and the variation about the mean. The studies were also designed in a manner that attempted to control for most, potentially large sources of variation, including meteorology (E and E 2004).

To assure that the measured concentration estimates that were obtained would represent conservative, bounding estimates of exposure associated with these activities, the studies were conducted at an undisturbed location that visually exhibiting among the highest levels of ACM contamination found anywhere at the North Ridge Estates site[1]. It is also known that this area, which is on an unoccupied parcel, was not included in any of the known, previous cleanup efforts. The studies were also conducted during the driest of conditions commonly encountered in Klamath Falls.

During the studies, air samples were collected from the breathing zone of each contractor conducting each activity. These were then prepared and analyzed to determine potential exposure concentrations in the air. Two such samples were collected for each trial of each simulated activity, but only one was analyzed. Ambient air samples were also collected at a nearby (upwind???) stationary location. The ambient samples were collected over the entire 8-hour period of each of the three days during which all of the multiple trials were conducted for each of the three selected activities. (Confirm?) All samples were analyzed using the counting and identification rules of the ISO Method 10312, but counts were limited to structures longer than 5 µm, which are believed to include the primary structures that contribute biological activity.

Dust concentrations and meteorology were also monitored during each experiment. Emitted dust was monitored by an automated particle counter that provides calibrated readouts (of what size range?) in one-minute intervals. The monitor was worn at waist height by the individual conducting each simulation. Wind speed and direction, temperature, and relative humidity were also determined over one minute intervals at an automated meteorological station setup in proximity to the study area.

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[1] Whether the visual cues employed in the field to select conservative "hot spots" of bulk asbestos concentrations indeed correlate with measured concentrations will be evaluated, once results from the analyses of the bulk samples from the selected locations become available. This also assumes that the manner in which each location was sampled proves adequate for characterizing the location.

Results and Interpretation

A summary of the asbestos measurements collected during the various simulations is provided in Table 1. In Table 1, the first column indicates the specific simulation type and the trial from which each sample was collected. The second column indicates the analytical sensitivity achieved during the analysis of each sample. The next four columns of the table indicate, respectively, the number of short protocol structures, long protocol structures, 7402 fibers, and 7402 structures counted during each analysis. The last four columns of Table 1 indicate, respectively, estimated concentrations for total protocol structures, the fraction of protocol structures that are long, estimated concentrations for 7402 fibers, and estimated concentrations for 7402 structures.

As indicated in Table 1, only one of the four trials conducted to simulate child's play in dirt was analyzed for the determination of asbestos. This was because the samples from the other three trials were overloaded (with dust) and could not be prepared by direct transfer for analysis. Similarly, only two of the three samples from the rototilling trials could be analyzed. Unfortunately, this means that the "between trial" variability in the exposure estimates from the simulations of these pathways cannot be determined.

Also as indicated in Table 1, no asbestos structures were detected on any of the ambient samples. I NEED TO CHECK AND INDICATE THE LOCATION OF THESE SAMPLES RELATIVE TO THE SIMULATION.

Note that the difference between 7402 fibers and 7402 structures is that the former includes only fibers and bundles while the latter includes any complex structure that would be expected to resemble a 7402 fiber at low magnification. This typically means, however, that while the mineralogy of 7402 fibers are commonly confirmed so that they can be considered to be asbestos, the mineralogy of 7402 structures is not typically confirmed. In fact, more often than not, these represent complex matrices (composed of a non-asbestos mineral) in which an asbestos fiber is embedded. For this reason, it is important to distinguish among 7402 structures that are appropriate for inclusion in counts to support risk assessment and those that should be excluded. Because it will not be possible to determine which 7402 structures are appropriate for consideration until the raw data become available, the contribution from 7402 structures to risk will be evaluated when the raw data become available and will not be addressed further at this time.

Dust concentrations collected during each simulation (measured at the waist of the individual conducting each simulation) were also evaluated and results are presented in Table 2. In Table 2, the first column indicates the specific activity simulated and the second column indicates the specific trial during which the dust measurements were obtained.

The third column of Table 2 indicates the mean dust concentrations observed during each trial. This was determined by averaging the individual concentration estimates for each minute of the time during which each trial of each simulation was being conducted.

The last column of Table 2 indicates the mean dust concentrations considered as potential background for each simulation. These were estimated by averaging individual concentration estimates for each minute of the time immediately before each trial was initiated and immediately after each trial was completed.

What is interesting about the dust measurements is that, while they confirm that substantial dust was generated during the simulations of child's play and of rototilling, relatively little dust was generated during weed-trimming. In fact, for all but the first trial for weed-trimming, background dust concentrations were either higher or as high as those observed during the actual trial. Thus, it appears that the dust generating potential for this pathway is limited relative to other pathways. This also complicates the interpretation of the asbestos measurements collected during weed-trimming. Nevertheless, the asbestos measurements from weed trimming are carried through the following analysis without modification.

The asbestos measurements collected during the simulations, which are reported in Table 1, were evaluated by adjusting them to provide time-averaged exposure estimates and then converting the time-averaged exposure estimates to risk estimates. Results of this evaluation are presented in Table 3.

In Table 3, the first column indicates the type of simulation evaluated. To facilitate comparison, modeling results reported in the recent soil report for the site (Berman 2004) are also listed in this table.

The second column of Table 3 indicates the source of the concentration estimates and the duration and frequency estimates used to convert the simulation measurements to time-averaged exposure estimates. The corresponding time-factor is presented in the third column of the table. The time-factor is simply the ratio of the number of lifetime hours spent conducting a specific activity (equal to the number of hours/day*days/year*years) over the total number of hours in a lifetime (24 hours/day*365 days/year*70 years). As described further below, duration and frequency estimates derived from several sources are addressed in the table.

The fourth through sixth column of Table 3 indicates, respectively, time-averaged exposure estimates for protocol structures, the fraction of long protocol structures, and the time-averaged exposure estimates for 7402 fibers. These are determined simply as the product of the exposure concentrations measured during (or estimated from) the indicated simulation in each row of the table

(obtained from Table 1) and the corresponding time factor listed in the same row. These either represent the maximum concentrations observed among the trials of the same activity or an upper bound estimate of the measured concentrations, as indicated in each row.

Time-averaged concentrations for the same activities evaluated during the simulations, which were modeled in the recent soil report (Berman 2004) are also indicated in Columns 4 through 6 of Table 3. These are copied from Table 19 of the soil report.

The last three columns of Table 3 indicate, respectively, the mineral types of asbestos structures measured (or modeled) and the estimated contribution to risk from each of the indicated activities, based either on concentrations of protocol structures or concentrations of 7402 fibers. For protocol structure concentrations, risks are estimated simply as the product of the reported protocol structure concentration and the appropriate unit risk factor (URF) selected from the bottom of Table 3. The appropriate URF is the one that matches the type of asbestos and the fraction of long structures among protocol structures. For 7402 fibers, risks are estimated as the product of the concentration of fibers and the U.S.EPA URF, also listed at the bottom of the table.

Given the magnitude of the uncertainties associated with the measurements from the simulations and the objective of providing conservative exposure and risk estimates that are, nevertheless, potentially informative for decision-making, exposure and risk estimates were derived in several ways[2]. First, the maximum exposure concentration measured during the simulations for each activity was combined with the corresponding, extremely conservative, duration and frequency estimates employed in the recent soil study (Berman 2004) to develop time-averaged estimates of exposure (and their associated risks).

The second set of time-averaged concentration estimates presented in Table 3 are conservative in a different manner than the first set of estimates described above. For this case, upper confidence bounds of the measured concentrations from each activity (derived based on Poisson statistics) are combined with more realistic but still conservative estimates of duration and frequency for the corresponding activity that are reported by the Colorado Department of Public Health and Environment (CDPHE 2003). These time estimates were used by regulators in Libby, Montana and at the Lowry Air Force Base in Denver, Colorado.

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[2]   This is to assure that estimates remain adequately health protective while avoiding the artificial inflation in estimates that can result when more than a small number of conservative factors are multiplied together. It is important to remember, for example, that the simulation estimates are already extremely conservative in that they are based on measurements collected over the driest part of the year at a location likely containing among the highest concentrations of asbestos available anywhere on the site.

As can be seen in Table 3, risks estimated from the simulation study range up to 2×10^{-4} (two in ten thousand), which suggests that further study is warranted. However, even this most conservative of the risk estimates derived from the simulation data is only a factor of two larger than the upper end of the risk range potentially considered acceptable by the U.S.EPA and other regulators when site-specific data are considered. Thus, because this range represents risks that are potentially acceptable on a permanent basis (and because any actual risks are likely to be lower), the data in Table 3 do not indicate that an imminent hazard exists. Rather, the data indicate that there is time to complete an adequate investigation of the North Ridge Estates site that will be suitable for supporting required risk-management and remediation decisions without contributing unacceptably to human health risk.

The above conclusions are consistent with the conclusions indicated in the recent, preliminary soil report for the site (Berman 2004). Interestingly, the risk estimates modeled in that report (which are also presented in Table 3 of this report[3]) appear comparable in magnitude to those derived from the simulations. As previously indicated, however, any formal comparison between such estimates would require explicit consideration of the differences in the manner in which conservatism is built into each estimate and the degree to which each estimate is conservative.

References

(NOTE I WILL HAVE TO COMPLETE THESE WHEN I GET BACK TO THE OFFICE)

Berman, W. (2004). Soil Sampling Results and Preliminary Risk Assessment for the North Ridge Estates Site, Klamath Falls, Oregon. Final Draft. July 6.

Ecology and Environment (2004). Cite the work plan

Colorado Department of Public Health and Environment. (2004). Regulation No. 8, Part B-Emission Standards for Asbestos, "The Control of Hazardous Air Pollutants", Colorado Air Quality Control Commission, CDPHE, March 30.

ISO Method 10312. Cite source.

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[3] Note that weed-trimming was not originally modeled because it was not expected to drive risk (as the results of the simulation appear to confirm).